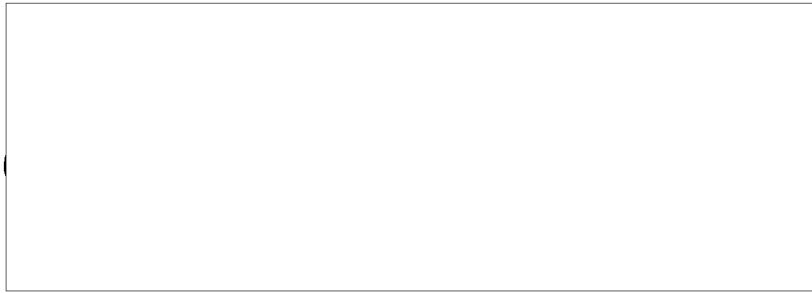


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Subject: Contract No. 605
Task Order No. 2
CS-8 Antenna
Final Report and Instruction Book
Submission of

Enclosure: (A) Instruction Book for CS-8 Antenna,
twenty (20) copies

(B) Final Report on a Broadband Logarithmically
Periodic Antenna, twelve (12) copies

Gentlemen:

Pursuant to the terms and provisions of the subject contract, the contractor submits Enclosures (A) and (B), described above, as fulfilling the requirements for instruction books and a final report as set forth therein. Due to the fact the subject contract does not set forth an applicable shipping address for the above enclosures, the enclosures are being transmitted to your attention with the understanding that the documents will be distributed to the applicable parties.

Very truly yours,

25X1

Contract Administrator
NKG:js

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MEMORANDUM RECEIPT

21 August 1959

DATE

TO: **OC-E - Attention:**

FROM: **Contracting Officer**

SUBJECT: **Contract No. 605
Task Order No. 2**

I hereby acknowledge receipt of the following:

19 copies of Instruction Book

11 copies of Final Report

Please return one signed copy(ies) of this receipt

To **CAB/PD/OL - 1305 Qtrs. Eye**

FORM NO. 752 REPLACES FORM 36-66
1 AUG 55

SIGNATURE OF RECIPIENT

DATE RECEIVED

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INSTRUCTION BOOK

ANTENNA CS-8

523 0024 00

15 JULY 1959

INSTRUCTION BOOK**CONFIDENTIAL****ANTENNA
CS-8****523 0024 00****15 JULY 1959**

PRINTED IN THE UNITED STATES OF AMERICA

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SECTION I
General Description

SECTION I
GENERAL DESCRIPTION

1.1 DESCRIPTION.

Antenna CS-8 is a broadband, logarithmically periodic antenna for use in the 55- to 600-mc range. Equipment is supplied for indoor and outdoor installation. Indoor installation requires a space 9 feet by 9 feet by 7 feet. The CS-8 can be adjusted for either vertical or horizontal polarization.

1.2 CHARACTERISTICS.

| | |
|-------------------------|--|
| Impedance: | 50 ohms, coaxial feed, unbalanced 150 ohms, twin lead, balanced |
| Gain: | 4-1/2 to 7-1/2 db over a dipole |
| VSWR: | less than 2-1/2 to 1 |
| Polarization: | horizontal or vertical |

1.3 FEED CABLES.

A 10-foot length and a 20-foot length of 50-ohm, type RG-8/U coaxial cable are provided so that the 50-ohm unbalanced feed line may be 10, 20, or 30 feet long. For the 150-ohm feed line, twin leads of 20 feet and 30 feet are supplied so that the line may be 20, 30, or 50 feet long.

SECTION II
Installation

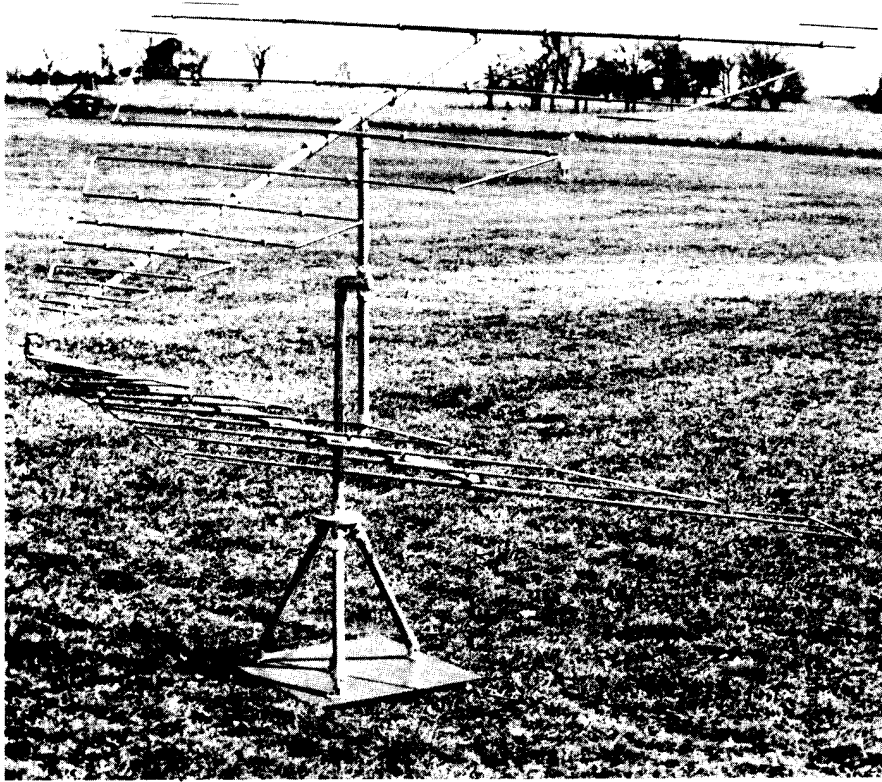


Figure 2-1a. Antenna Mounted for Indoor Use, Horizontally Polarized

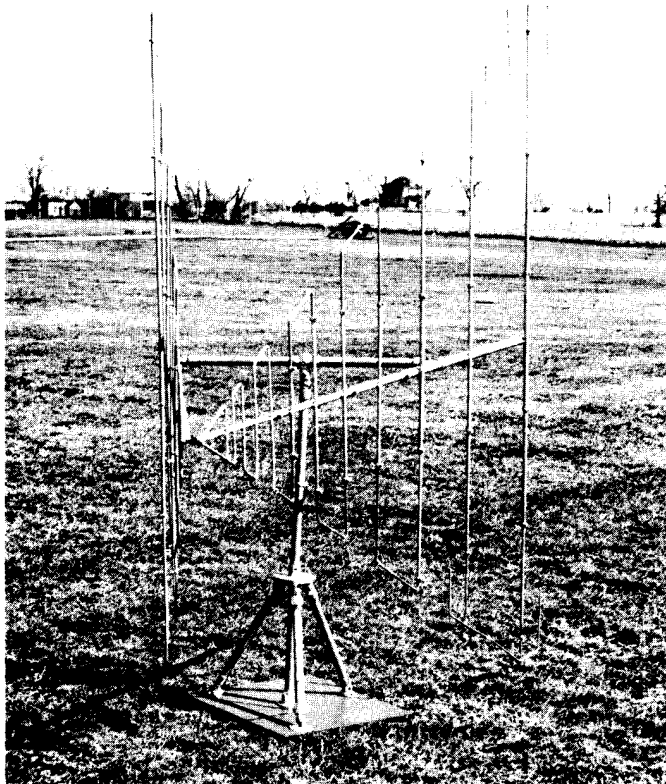


Figure 2-1b. Antenna Mounted for Indoor Use, Vertically Polarized

SECTION II
INSTALLATION

2.1 GENERAL.

Antenna CS-8 can be installed indoors or outdoors, as shown in figures 2-1a, 2-1b, 2-2a, and 2-2b, and can be set up for vertical or horizontal polarization. A tripod assembly is provided for indoor installation in a room at least 9 feet by 9 feet by 7 feet.

2.2 ANTENNA BOOM AND ELEMENT ASSEMBLIES.

2.2.1 LOWER BOOM AND ELEMENTS.

Refer to figure 2-3 and begin at the front (small) end of the lower boom to assemble the lower boom and elements. Observe that the elements are above the boom on the drawing. If the lower boom section is constructed properly, there will be no jumper where the mast of the antenna must pass when the antenna is being changed for polarization. Proceed as follows:

- a. Insert the conductor assembly, item Y, into the boom section, item B, as shown.
- b. Insert the conductor assembly, item W, into the boom section, item B, engaging the male connector on the conductor assembly, item Y, with the female connector on the conductor assembly, item W. Slide the conductor assembly, item W, farther into the boom section, item B, up to the scribed line. Align the elements into the same plane and tighten the clamp.
- c. Insert the conductor assembly, item Z, into the boom section, item C. Then insert the conductor assembly, item Z, into the conductor assembly, item Y, engaging connectors on the inner conductors.
- d. Slide the boom section, item C, over the conductor assemblies, items Y and Z, and onto the forward boom section, item B, up to the scribed line. Align the elements into the same plane and tighten the clamp.
- e. Insert the conductor assembly, item AA, into the boom section, item D. Insert the conductor assembly, item AA, into the forward conductor assembly, item Z, engaging the connectors on the inner conductors.
- f. Slide the boom section, item D, over the conductor assembly, item AA, and onto the forward boom section, item C, up to the scribed line. Align the elements into the same plane and tighten the clamp.
- g. Insert the conductor assembly, item AB, into the boom section, item E. Insert the conductor assembly, item AB, into the forward conductor assembly, item AA, engaging the connectors on the inner conductors.
- h. Slide the boom section, item E, over the conductor assembly, item AB, and onto the forward boom section, item D, up to the scribed line. Align the three holes in the end of the boom section, item E, with the tapped holes in the end of the conductor assembly, item AB, and secure with screws, item AC. Align the elements into the same plane and tighten the clamp.
- i. Insert the element extensions, items L, M, and N, into the boom assemblies up to the scribed lines and tighten the clamps.

SECTION II
Installation

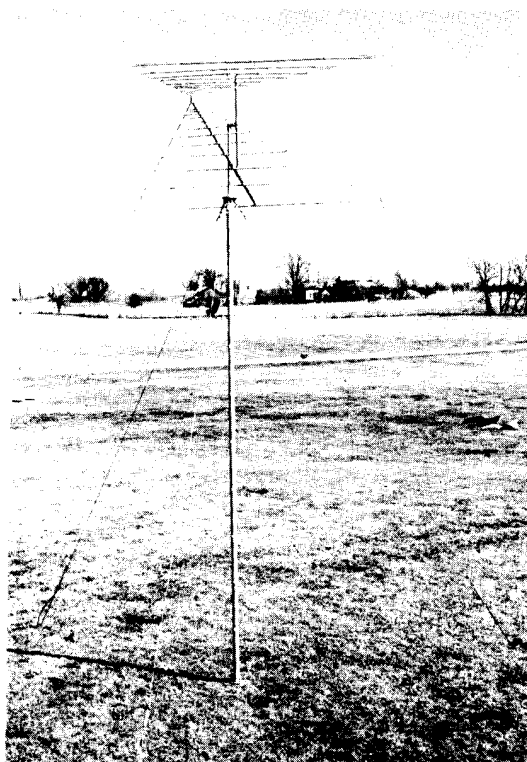


Figure 2-2a. Antenna Mounted for Outdoor Use, Horizontally Polarized

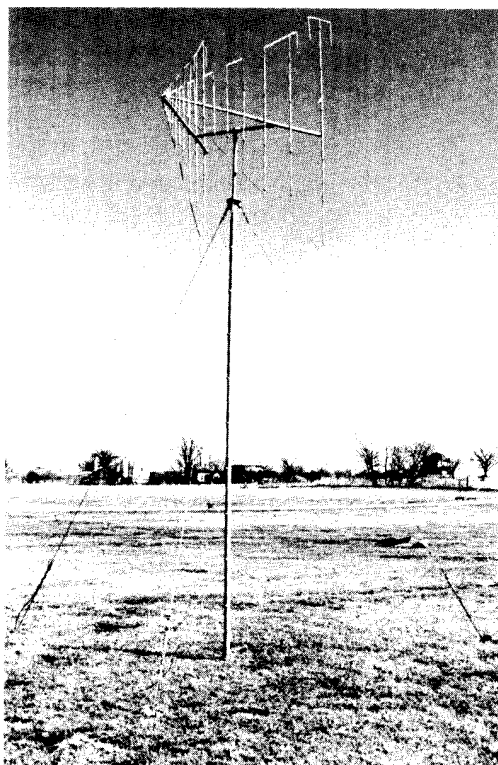


Figure 2-2b. Antenna Mounted for Outdoor Use, Vertically Polarized

SECTION II

Installation

j. Beginning at the front end of the boom assembly, item W, insert the jumpers, items F, G, H, J, and K, into all element extensions up to the scribed lines and tighten the clamps.

k. Insert the loading elements, items P, R, S, and T, into the element extensions up to the scribed lines and tighten the clamps.

l. After all clamps and screws are secured, turn the assembly over so that the elements are underneath the boom. The assembly will be used in this manner when the antenna is in the operating position.

2.2.2 UPPER BOOM AND ELEMENTS.

The upper boom does not contain the inner conductor as does the lower boom. However, assemble the upper boom in a similar manner to the lower boom. Keep the antenna elements above the boom sections during assembly. The assembly will be used in this manner when the antenna is in the operating position. This will assure staggering of the upper and lower jumpers; a jumper on the upper boom will not have a jumper immediately below it. Referring to figure 2-3, proceed as follows to assemble the upper boom and elements:

a. Insert the boom section, item V, into the following boom section, item B, up to the scribed line. Align the elements into the same plane and tighten the clamp.

b. Insert the boom section, item B, into the following boom section, item C, up to the scribed line. Align the elements into the same plane and tighten the clamp.

c. Insert the boom section, item C, into the following boom section, item D, up to the scribed line. Align the elements into the same plane and tighten the clamp.

d. Insert the boom section, item D, into the last boom section, item U, up to the scribed line. Align the elements into the same plane and tighten the clamp.

e. Insert the element extensions, items L, M, and N, into the boom assemblies up to the scribed lines and tighten the clamps.

f. Beginning at the front end of the boom assembly, item V, insert the jumpers, items F, G, H, J, and K, into all element extensions up to the scribed lines and tighten the clamps.

g. Insert the loading elements, items P, R, S, and T, into the element extensions up to the scribed lines and tighten the clamps.

h. Secure all of the jumper and loading-element splices with screws, item AE, and nuts, item AF.

2.3 INDOOR INSTALLATION.

Having completed assembly of the booms and elements, refer to figure 2-4 and use the following procedure to install Antenna CS-8 indoors:

a. Place the removable box cover, item AS, on the floor in the center of the room. Install the round flange base, item AU, using three flat-head screws, item BD.

b. Insert the mast section, item AK, into the round flange base, item AU.

c. Slip the bearing assembly, item AM, over the mast-bearing section, item AL, as shown.

d. Insert the mast-bearing section, item AL, into the mast section, item AK, and tighten the screw clamp on the mast section, item AK.

SECTION II

Installation

- e. Attach the top of the tripod legs, item AP, to the bearing assembly, item AM, using screws, item BG, and nuts, item BC. Attach the bottom of the tripod legs, item AP, to the removable box cover, item AS, using screws, item BG.
- f. Install the mast assembly section, item AN, on the mast-bearing section, item AL, and tighten the screw clamp on the mast assembly section, item AN.
- g. Insert the two antenna spacers, item AR, into the mast assembly section, item AN, and tighten the setscrews on the mast assembly section, item AN.
- h. Install the lower boom assembly, item AH, on the lower antenna spacer, item AR, as shown, and tighten the setscrew on the lower boom assembly, item AH.
- i. Install the upper boom assembly, item AG, on the upper antenna spacer, item AR, as shown.
- j. Install the two halves of the apex insulator, item AJ, at the front tip of the boom assemblies, items AG and AH, and secure with the two screws, item BH, and nuts, item BC, so that a quarter-inch gap is provided between the boom tips as shown.

NOTE

For the 150-ohm balanced feed, omit steps k and l below, or do not connect the coaxial cable, item BK, and one side of the feed strap, item AT. For the 50-ohm unbalanced feed, omit step m below, or do not connect the twin lead, item BP, at the front end of boom AG and AH.

- k. Install the coaxial cable assembly, item BK, with clamps, items AW and AV, using screws, item BF, and nuts, item BB. Connect the coaxial feed-line connector to the N-type (female) connector at the rear of the lower boom, item AH.

- l. Refer to the drawing of the feed-strap detail and install the copper end of the feed strap, item AT, to the front end of the lower boom with a lock washer, item AY, and a nut, item BA. Attach the zinc-plated end of the feed strap to the front end of the upper boom with a lock washer, item AZ, and a screw, item BE.

- m. Connect the twin lead, item BP, to the two screws provided at the front end of both booms, as shown in the drawing of the twin-lead detail. Attach a stand-off insulator, item BQ, to the mast section assembly, item AN. Thread the twin lead into the stand-off insulator, item BQ.

2.4 OUTDOOR INSTALLATION.

Having completed assembly of the booms and elements, refer to figure 2-5 and use the following procedure to install Antenna CS-8 outdoors:

- a. Choose a site unobstructed as much as possible by surrounding terrain or buildings.
- b. Place the bottom plate assembly, item BV, on level ground. Drive the four anchor rods, item CB, through the holes in the bottom plate and into the ground at least five inches.
- c. Refer to the guying layout on figure 2-3 and use the drive rod, item DA, to stake the three anchors, item CN, to a minimum depth of 18 inches.
- d. Assemble the 1-1/2-inch pipe mast, items BZ, BY, and BW. Item BZ is the top section of the mast; item BW is the bottom section. Use as many intermediate sections, item BY, as desired for antenna height. Lay the assembled 1-1/2-inch pipe mast aside until the antenna proper is assembled.

SECTION II
Installation

- e. Slip the bearing assembly, item AM, over the mast-bearing section, item AL, as shown, install the mast section assembly, item AN, on the mast-bearing section, item AL, and tighten clamp on item AN.
- f. Insert the two antenna spacers, item AR into the mast section assembly, item AN, and tighten the setscrews on item AN.
- g. With the lower boom, item AH, lying on the ground with the elements under the boom, insert the free end of the antenna spacer, item AR, into the coupler on the lower boom, item AH, as shown. Tighten the setscrew on the lower boom, item AH.

CAUTION

Do not support the weight of the antenna with the elements in a vertical position during assembly. Be careful not to bend the elements in any manner.

- h. Install the upper boom, item AG, on the upper antenna spacer, item AR, and tighten the setscrew on the upper boom, item AG.
- i. Install the two halves of the apex insulator, item AJ, at the front tip of the boom assemblies, items AG and AH. Secure with the two screws, item BH, and nuts, item BC, so that a quarter-inch gap is provided between the boom tips as shown.

NOTE

For the 150- ohm balanced feed, omit steps j and k below, or do not connect the coaxial cable, item BK, and one side of the feed strap, item AT. For the 50-ohm unbalanced feed, omit step m below, or do not connect the twin lead, item BP, at the front end of booms AG and AH.

- j. Install the coaxial cable assembly, item BK, with clamps, items AW and AV, using screws, item BF, and nuts, item BB. Connect the coaxial feed-line connector to the N-type (female) connector at the rear of the lower boom, item AH.
- k. Refer to the drawing of the feed-strap detail. Install the copper end of the feed strap, item AT, to the front end of the lower boom with a lock washer, item AY, and a nut, item BA. Attach the zinc-plated end of the feed strap to the front end of the upper boom with a lock washer, item AZ, and a screw, item BE.
- l. Connect the twin lead, item BP, to the two screws provided at the front part of both booms, as shown in the drawing of the twin-lead detail. Attach the stand-off insulators, item BQ, to the mast section assembly, item AN, to the 1-1/2-inch pipe mast, item BZ, and to every other intermediate 1-1/2-inch pipe mast sections, item BY. Thread the twin lead into the stand-off insulators, item BQ.
- m. Install the assembled antenna portion to the top of the 1-1/2-inch pipe mast by inserting the mast bearing section, item AL, into the top of the 1-1/2-inch pipe mast, item BZ. Line up the holes in these parts and secure with screw, item CR, and nut, item CK.
- n. Attach the shackles at the ends of the three guy assemblies, item CA, to the bearing assembly, item AM, as shown, and secure.

SECTION II

Installation

o. Lift the assembled antenna and mast to a vertical position and insert the bottom portion of the 1-1/2-inch pipe mast, item BW, into the bottom plate assembly, item BV.

p. Hook the lower ends of the three guy assemblies, item CA, to the three anchors, item CN. Adjust the guy length and the turnbuckles until the mast is plumb and rigidly supported. Tighten the setscrews on the bottom plate, item BV.

2.5 POLARIZATION CHANGE. (See figure 2-6.)

2.5.1 POLARIZATION CHANGE FOR INDOOR INSTALLATION.

Proceed as follows to change polarization of Antenna CS-8 installed indoors:

a. If the room space is close to the prescribed minimum, loosen the longer element extensions and telescope them inward.

b. Loosen the bolt on the mast section assembly, item AN, if necessary.

c. Take hold of the antenna booms, items AG and AH, and turn the antenna section to the desired position. The antenna is horizontally polarized with the elements in a horizontal position, vertically polarized with the elements in a vertical position.

d. Tighten the bolt on the mast section assembly, item AN, if necessary.

e. If the element extensions were loosened, reset them at the scribed lines and tighten the clamps.

NOTE

If the size of the room is exactly 9 feet by 9 feet by 7 feet, the longest elements will touch the ceiling when the antenna is vertically polarized because the leverage action of the heavier front end lifts the rear elements slightly. To remedy this situation, shorten the longest elements by approximately one-half inch so that they will not touch the ceiling.

2.5.2 POLARIZATION CHANGE FOR OUTDOOR INSTALLATION.

Proceed as follows to change polarization of Antenna CS-8 installed outdoors:

a. Unhook two of the guy assemblies, item CA, loosen the setscrews on item BV, lift the mast out of the bottom plate, item BV, and lower the mast to the ground.

b. Loosen the bolt on the mast section assembly, item AN, if necessary.

c. Take hold of the antenna booms, items AG and AH, and turn the antenna section to the desired position. The antenna is horizontally polarized with the elements in a horizontal position, vertically polarized with the elements in a vertical position.

d. Tighten the bolt on the mast section assembly, item AN, if necessary.

e. Lift the antenna and mast to a vertical position and insert the bottom portion of the 1-1/2-inch pipe mast, item BW, into the bottom plate assembly, item BV.

f. Hook the lower ends of the three guy assemblies item CA, to the three anchors, item CN. Adjust the guy length and the turnbuckles until the mast is plumb and rigidly supported. Tighten the setscrews on the bottom plate, item BV.

2.6 ANTENNA DIRECTION.

Antenna CS-8 may be thought of as an arrow that points toward the direction of its greatest sensitivity.

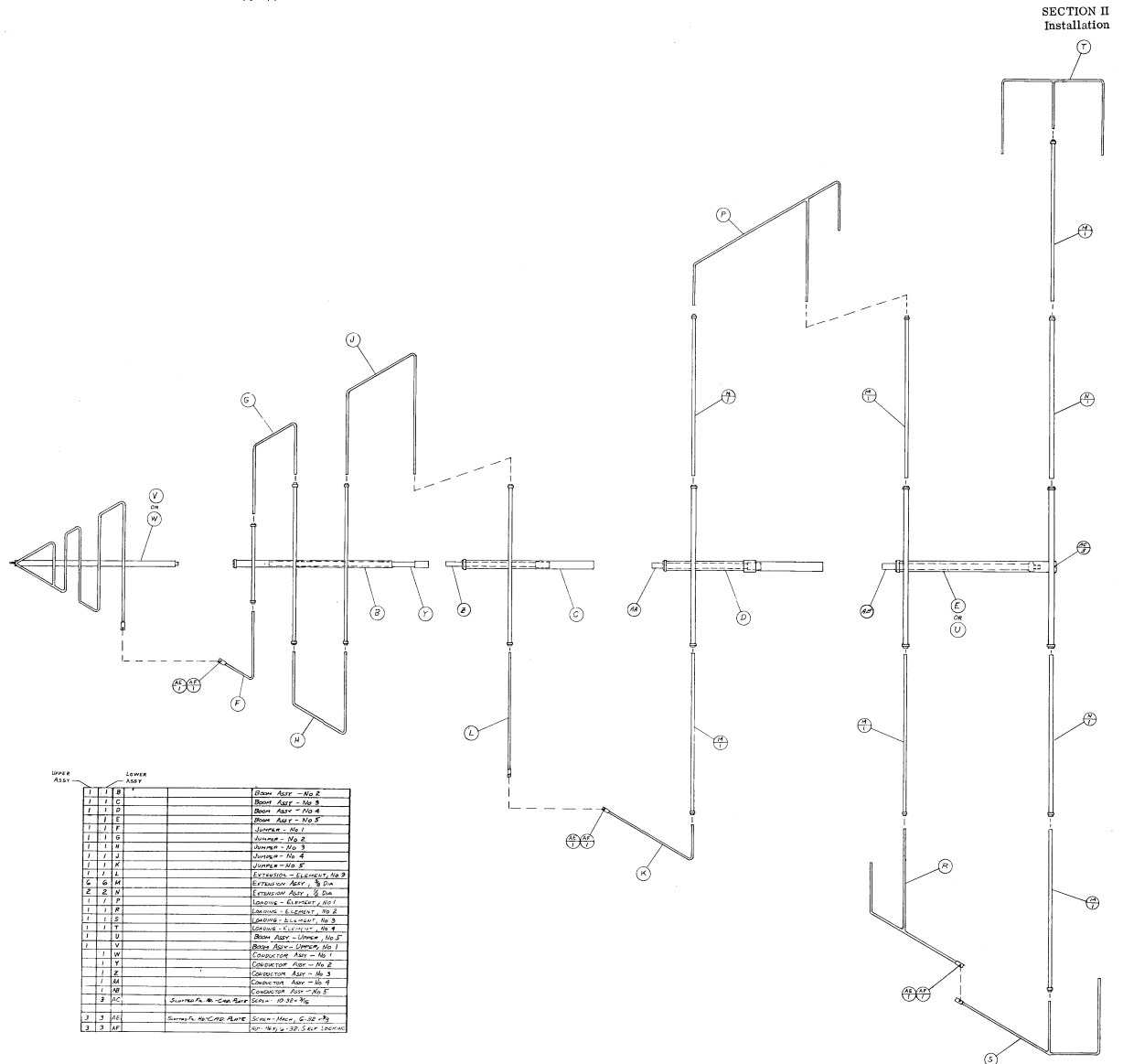


Figure 2-3. CS-3, Boom and Element Assemblies

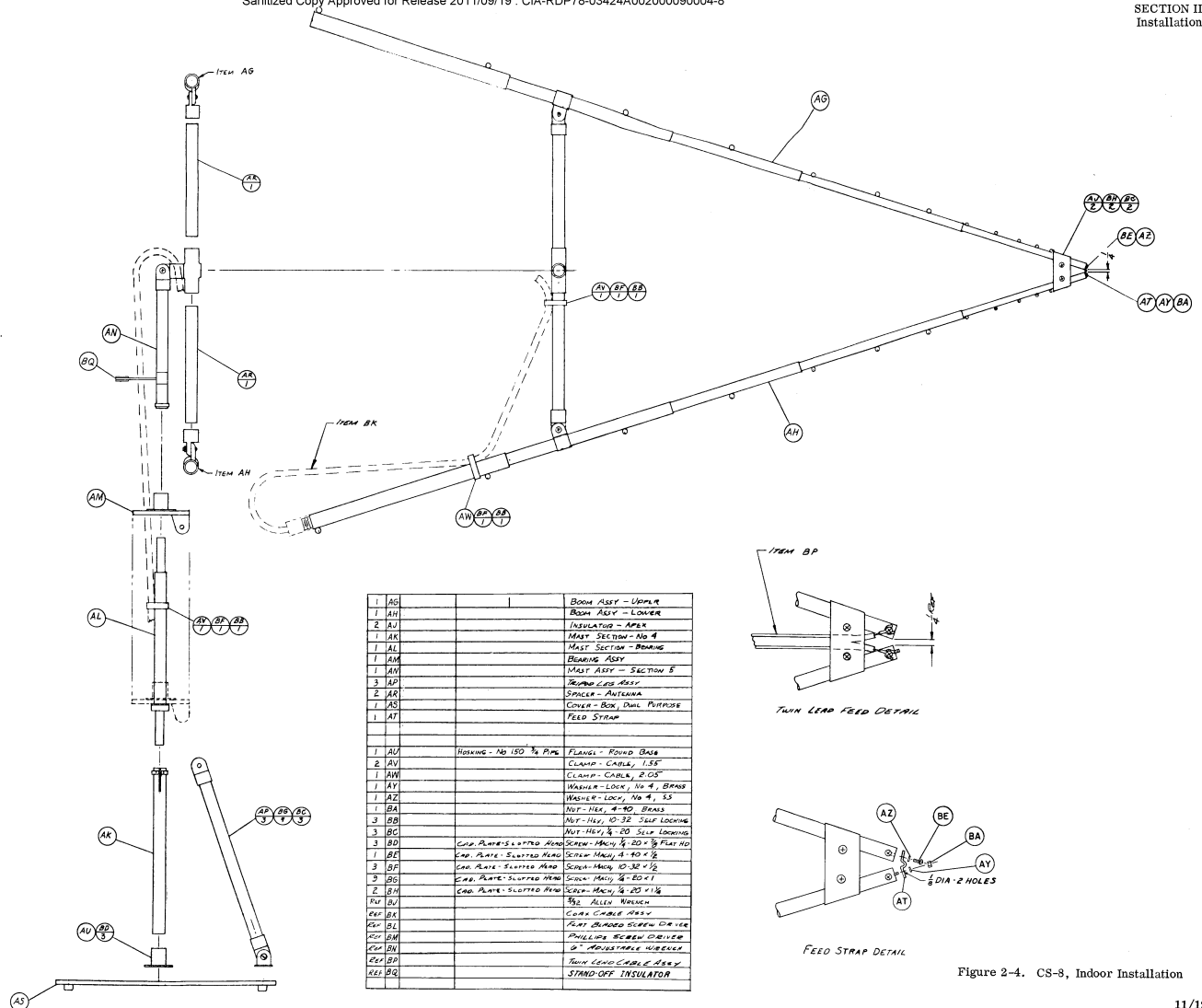


Figure 2-4. CS-8, Indoor Installation

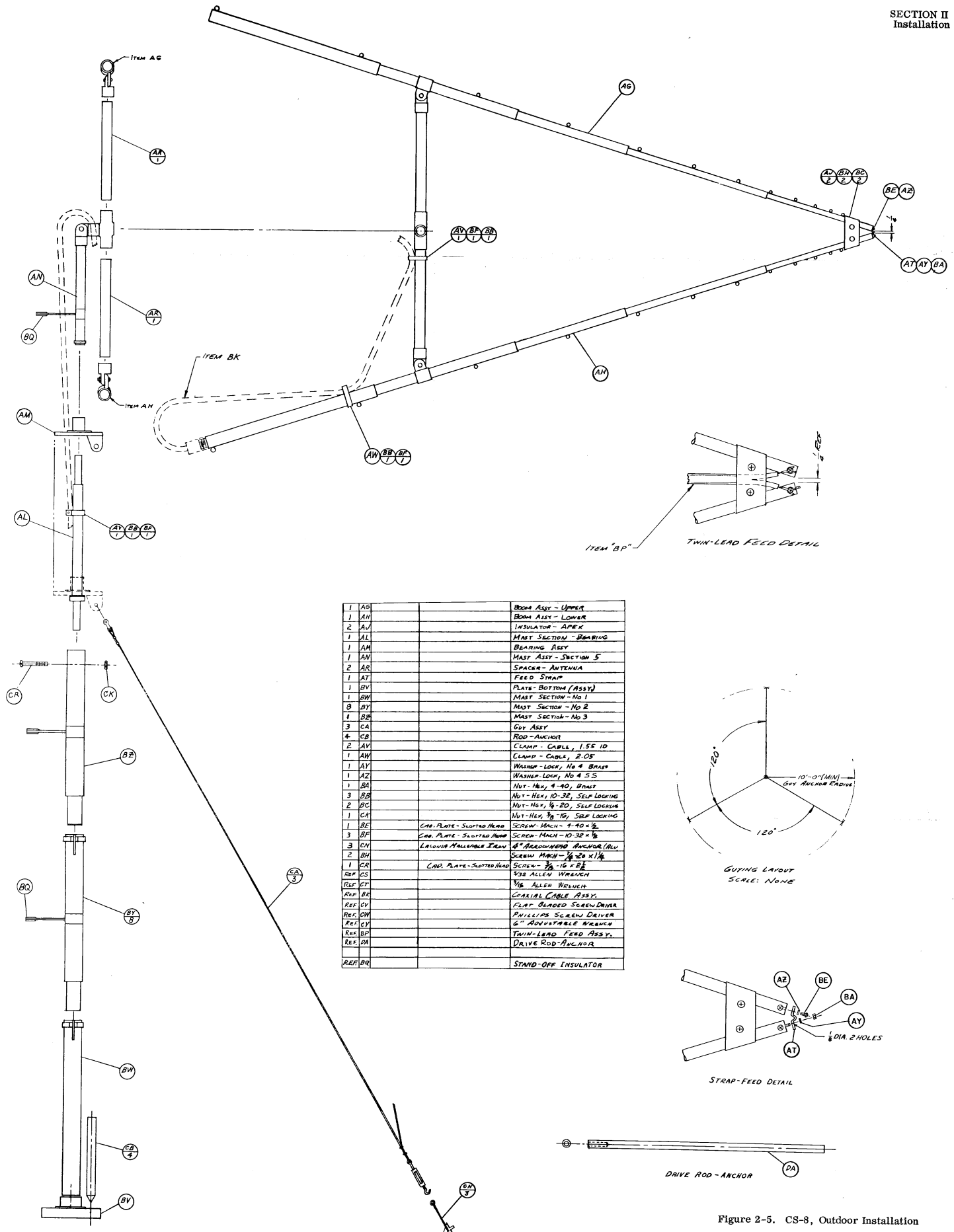
SECTION II
Installation

Figure 2-5. CS-8, Outdoor Installation

SECTION II
Installation

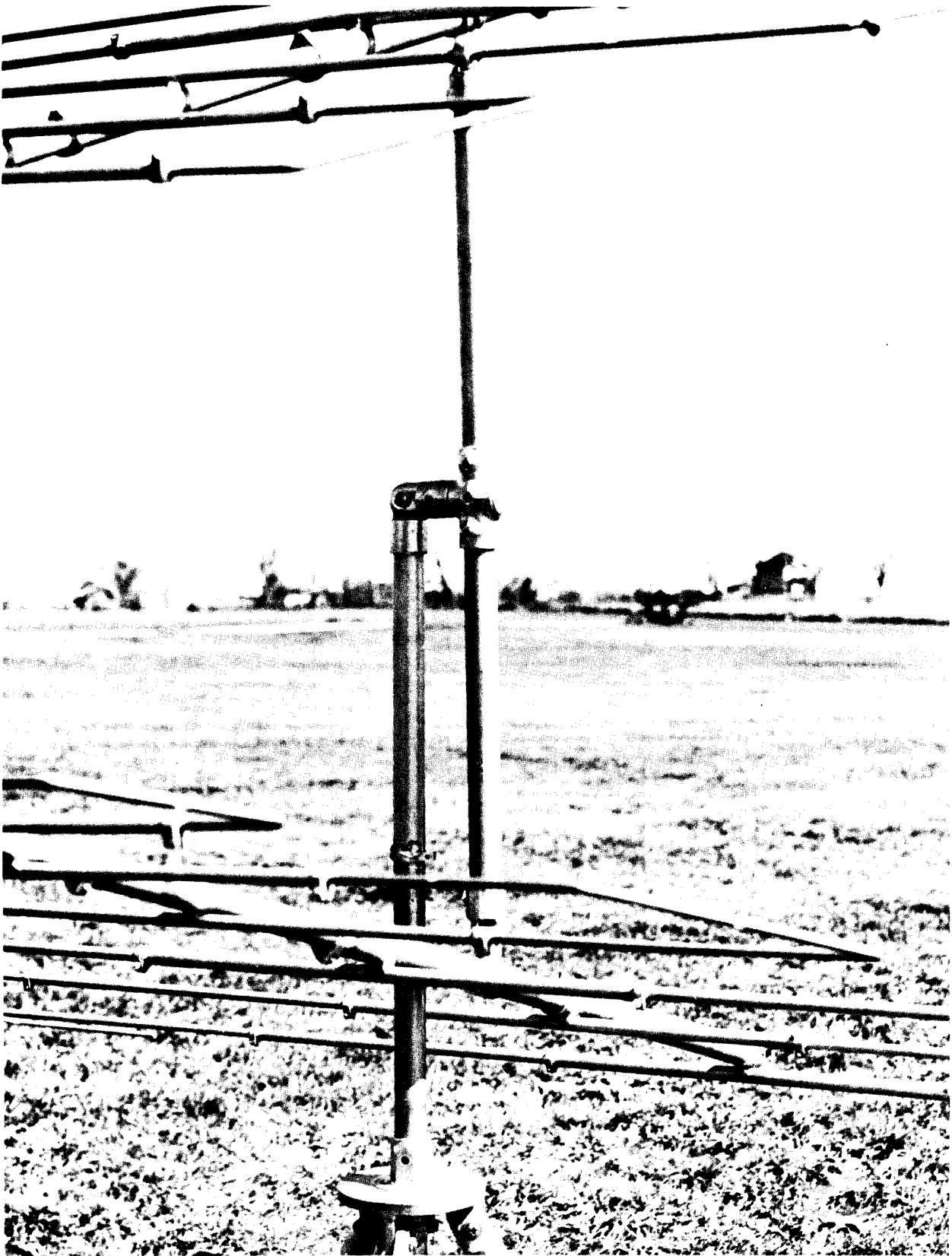


Figure 2-6. Photograph Showing How
Polarization Change is Obtained

SECTION III

PRINCIPLES OF OPERATION

3.1 GENERAL.

Logarithmically periodic antennas are a general class of structures whose geometry is chosen so that the input impedance and radiation pattern must vary periodically with the logarithm of the frequency. If the variation of these characteristics over a period is small, it will therefore be small for all periods, the result being an extremely broad-band antenna. Fortunately, there are several types of logarithmically periodic structures for which this variation is small.

3.2 DESCRIPTION.

Figure 3-1 shows a sketch of the design parameters from which the CS-8 Antenna has been derived. This structure consists of two triangular halves with the ends of the transverse wires being defined by the angle α and the angle between the two halves denoted by ψ . The third defining parameter of the antenna is the design ratio τ which is equal to R_n/R_{n+2} . It is this ratio that defines the periodicity of a structure. That is, if the structure were infinitely long, it would look exactly the same to a generator located at the feed point every time the frequency is changed by the factor τ . Therefore, the input

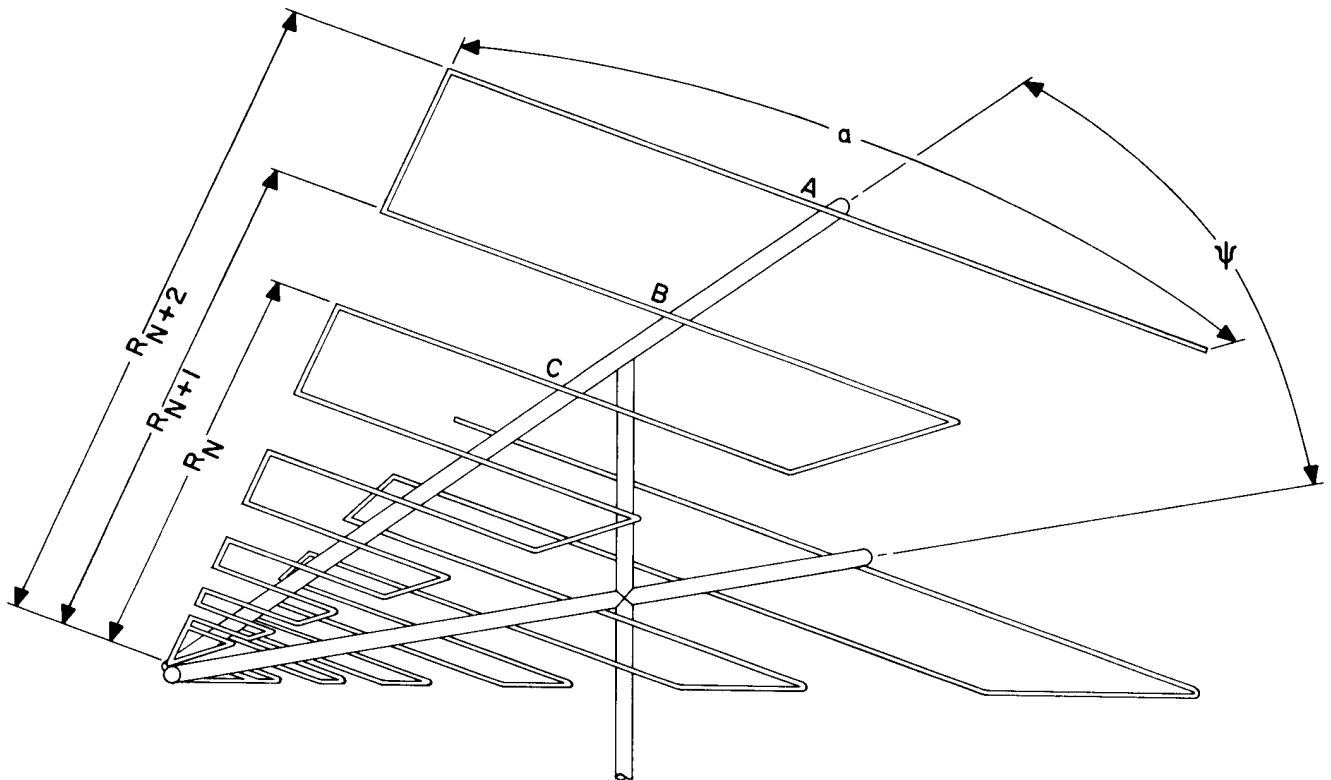


Figure 3-1. Diagram, Design Parameters, Unidirectional Log Periodic Antennas

SECTION III

Principles of Operation

impedance or radiation pattern must repeat every time the frequency is changed by this factor. A period of frequency is defined by the frequency band of τf to f . The structure as shown is horizontally polarized and produces a beam in the direction in which the antenna points. The two halves of the structure are fed against each other at the vertices with a coaxial line which runs up the center line of one half of the structure. The low frequency limit of the antenna occurs when the longest transverse element, that is, element A, is approximately one-half wavelength long. As the frequency is increased, a smaller and smaller portion of the antenna is used to produce the beam. As one progresses from the feed point, it is found that the currents drop off quite rapidly after the point where a one-half wavelength long transverse element exists. The high frequency limit is obtained when the shortest transverse element is approximately one-quarter wavelength long.

The parameters which were chosen for this antenna are $\alpha = 60^\circ$, $\psi = 35^\circ$ and $\tau = .6^\circ$. These parameters give a compromise between the gain and front-to-back ratio. By varying the parameters, higher gain can be achieved, but the front-to-back ratio will decrease. Conversely, if greater front-to-back ratio is required, the gain will decrease. These changes in performance can be obtained by varying the design parameters to give the desired results.

3.3 FULL-SCALE MEASUREMENTS.

Figures 3-2 and 3-3 show a series of patterns taken over the entire frequency range of the antenna. Figure 3-2 represents the azimuthal plane patterns for horizontal polarization, and figure 3-3 represents the azimuthal plane patterns for vertical polarization. The large beam widths in the vertical-polarization patterns at the lower frequencies are due to the capacity end-loading of the antenna. The gain figures shown in figure 3-4 are calculated figures as obtained from the principal-plane, half-power beam widths of the measured patterns. Figures 3-2 and 3-3 also show patterns taken above the upper design limit to show the deterioration of the principal beam and the decrease in front-to-back ratio. The patterns of figure 3-5 show the increase in cross polarization when going below the lower cutoff frequency. Figure 3-6 shows a plot of vswr versus frequency. This plot also shows vswr measurements beyond the upper and lower design limits.

SECTION III Principles of Operation

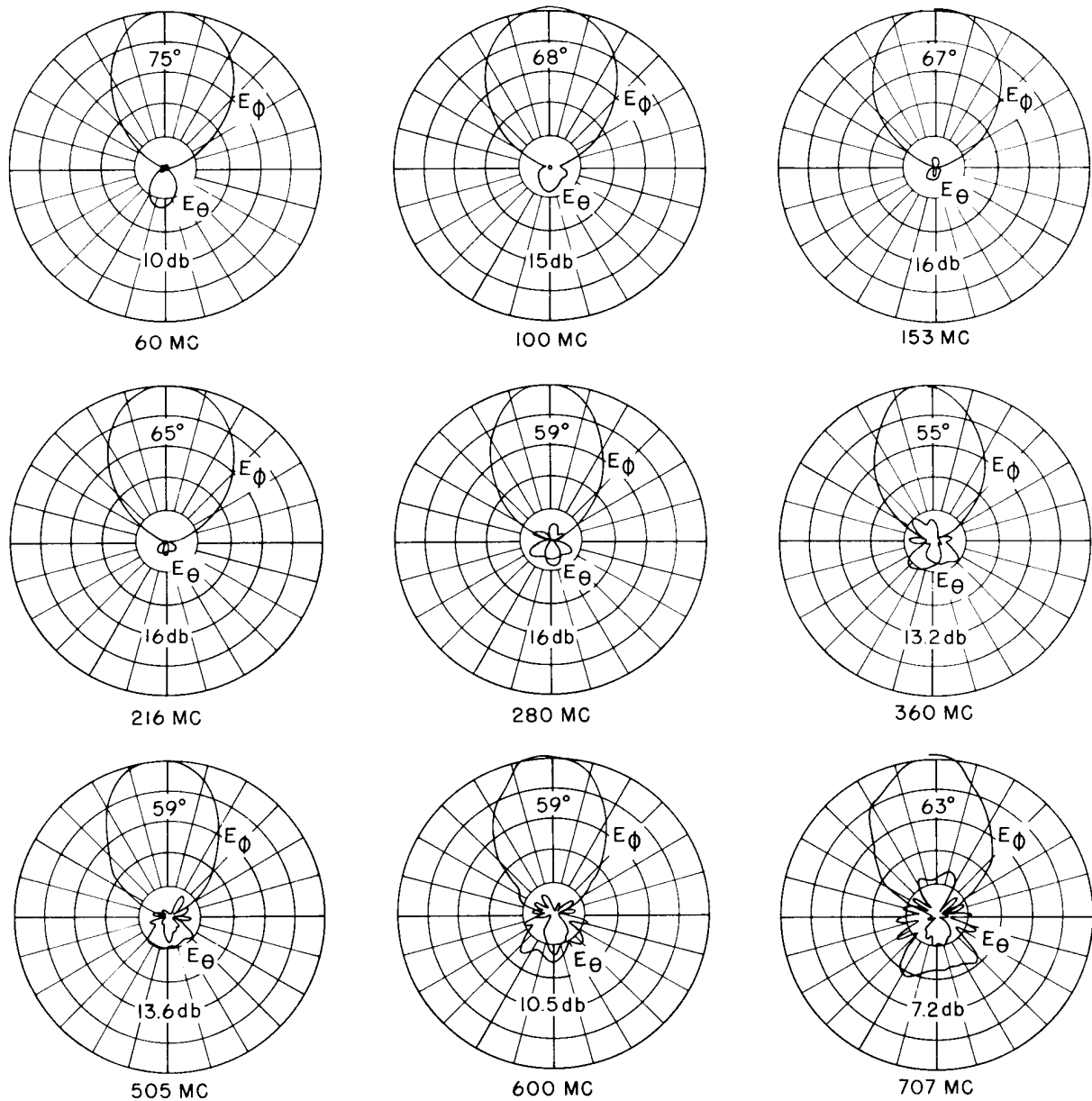


Figure 3-2. Horizontal Polarization Relative Voltage Patterns Taken in Azimuthal Plane

SECTION III

Principles of Operation

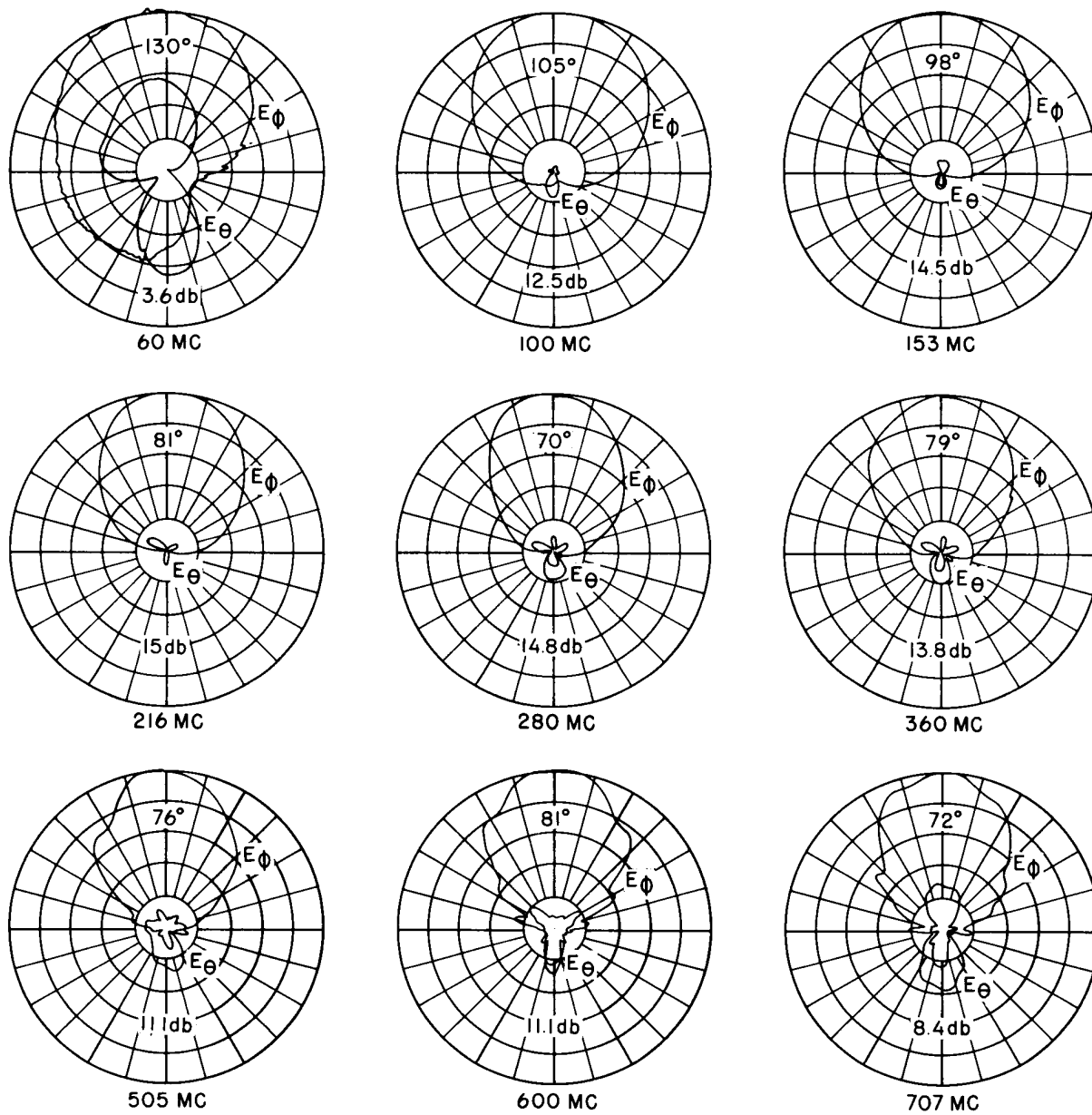


Figure 3-3. Vertical Polarization Relative Voltage Patterns Taken in Azimuthal Plane

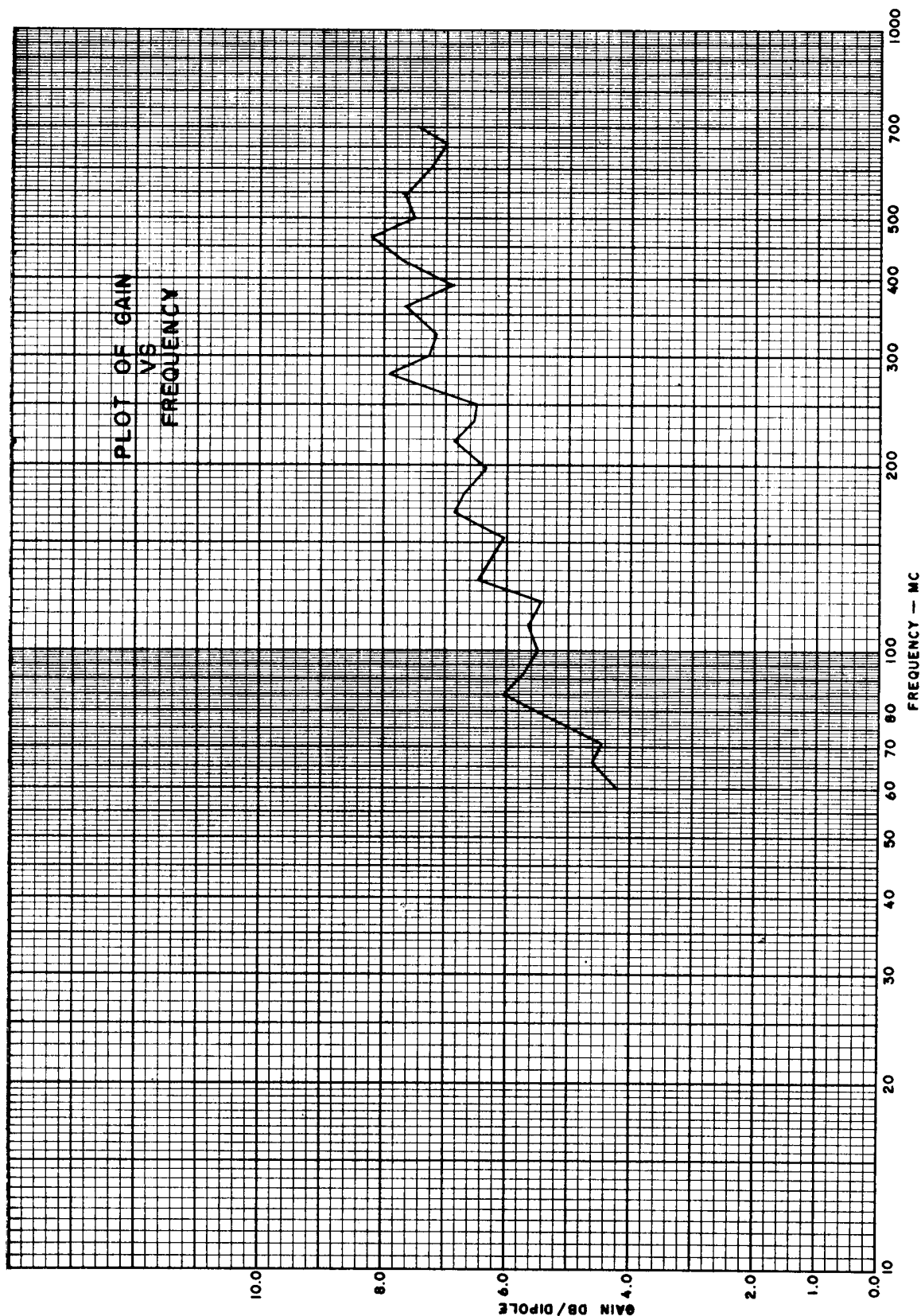
CONFIDENTIALSECTION III
Principles of Operation

Figure 3-4. Plot of Gain Versus Frequency

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Principles of Operation

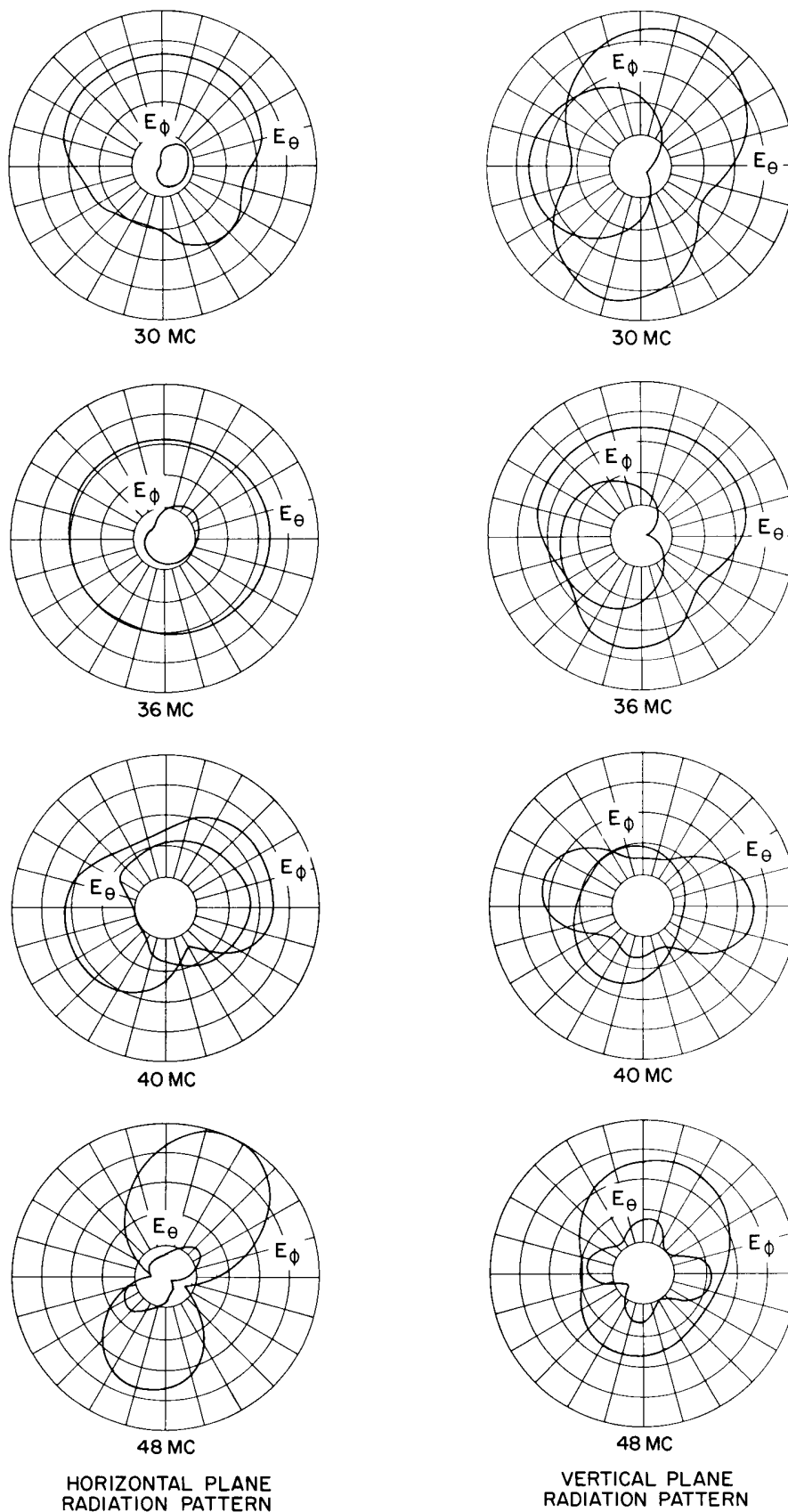


Figure 3-5. Radiation Patterns Below the Lower Cutoff Frequency

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